



Benchmarking

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Benchmarking Basics

■ Definition: Process of comparison against standard or average

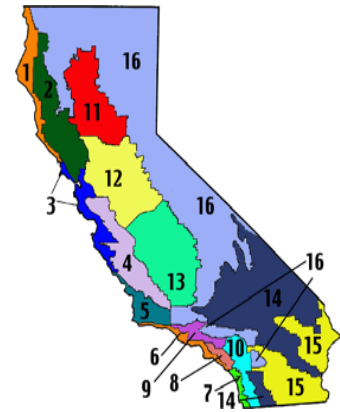
- ☐ Determine how well a building is performing
- ☐ Set targets for improved performance
- ☐ Facilitate assessment of property value
- ☐ Gain recognition

■ What influences energy use?

- ☐ Type (Office, Restaurant,..)
- ☐ Size, hours of use, occupancy
- ☐ Climate, heating and cooling
- ☐ Vintage, structural characteristics, Shading/Orientation
- ☐ Buildings systems, HVAC, shell, lighting
- ☐ Level of service, misc. loads

■ Why regional tools?

- ☐ Climate is main source of variation, influences design, end-uses
- ☐ Varying codes, incentives





Benchmarking and the Green Building Action Plan

1. Existing State buildings > 50kft² shall **meet LEED-EB** (including Energy Star > **75 or equivalent**) by 2015
2. State buildings will **reduce energy by 20% by 2015 or achieve CEC minimum efficiency** benchmark
3. CEC shall propose by July 2005 a **simple efficiency benchmarking system** coordinated with Energy Star
4. CEC shall **prepare a plan to accomplish benchmarking** for all buildings including tenants, buyers, and lenders

EPA Energy Star Basics

- **Energy Performance Rating based on regression model from DOE/EIA CBECS.**
- **Energy Star Label: Plaque awarded to buildings representing top 25% of their building category**
 - K-12 Schools, Offices, Hotels, Medical Offices, Supermarkets & Warehouses

Regression Equation

Source (kBtu/year) = $C_0 + C_1 \ln(\text{Area}) + C_2 \text{CDD} + C_3 \text{Hours} + C_4 \text{OccDens} + C_5 \text{PCDens}$

Source (kBtu/year) = $-42.215 + 14.967 \cdot \ln(\text{Area}) + 0.012 \cdot \text{CDD} + 0.517 \cdot \text{Hours} + 16.766 \cdot \text{OccDens} + 9.759 \cdot \text{PCDens}$

Predicted Source EUI = 250.3 kBtu/ft²-yr

Mean Source EUI = 201.7 kBtu/ft²-yr

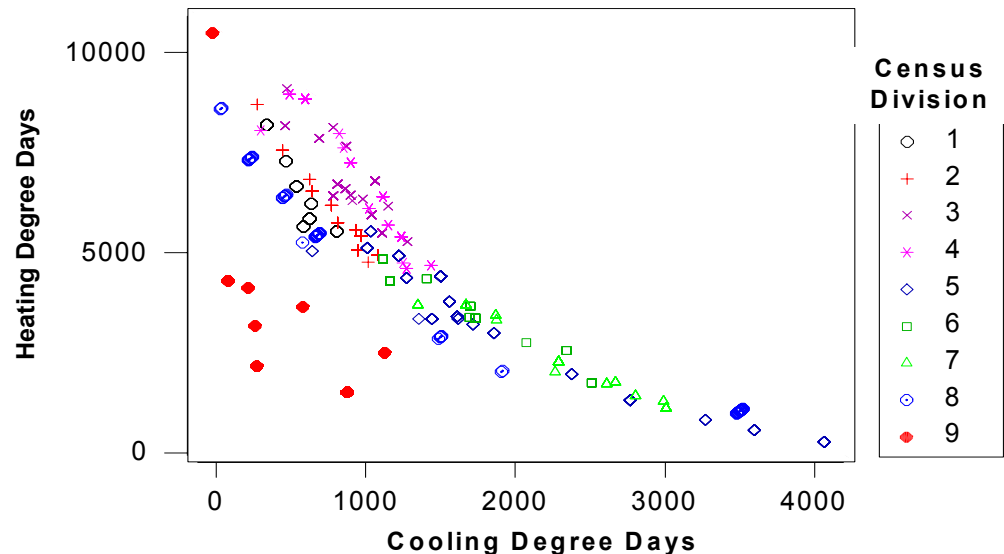
Adjustment Factor = (250.3/201.7)

= 1.24



Past Benchmarking Work

- Pre-EnergyStar energy data base research in 1980s
- EPA collaboration during development of Energy Star
- Simultaneous development of Arch and Cal-Arch
- Evaluated Scores of from 1990s Commercial End-Use Survey (CEUS)
 - Influenced Energy Star Algorithms
 - Re-evaluated Energy Star Ratings with new algorithm
- Plan for new benchmarking tool using CEUS
 - 2002 CEUS: 2,800 commercial audits with DOE-2 simulations



California Building Energy Reference Tool - Netscape

File Edit View Go Communicator Help

Back Forward Reload Home Search Guide Print Security Stop Netscape

Bookmarks Location: http://poet.lbl.gov/testarch/compare.html

CALARCH

CALIFORNIA BUILDING ENERGY REFERENCE TOOL

[HOME](#) | [BENCHMARK](#) | [ABOUT CalARCH](#) | [MORE INFORMATION](#)

[Back - Getting Started](#) [Compare](#) [Interpret Results](#)

1 Select the **principal activity** of your building:

Office/Professional

2 Enter the building's **floor area**, (gross square feet)
If both **floor area** and energy use are entered, an **EUI** will be calculated for your building and displayed on the graph.

☐ Check here to display only buildings with comparable floor area.

3 Enter the **annual energy consumption** for your building for each fuel used:

Fuel	Energy Consumption
Electricity	kWh/year
Natural Gas	therms/year
Other	Million Btu/year

☐ Check here if the data entered represents whole building energy use.

4 Enter the **zipcode** your building is located in.

If a zip code is entered, only buildings within the same **climate zone** will be displayed. Use this field only if your building is within PG&E or SCE service territory.

5 Select how **energy use** should be reported: ☒ Site ☐ Source

6 ☐ Check here if you are entering real data and think they would be useful to [add to our database](#)

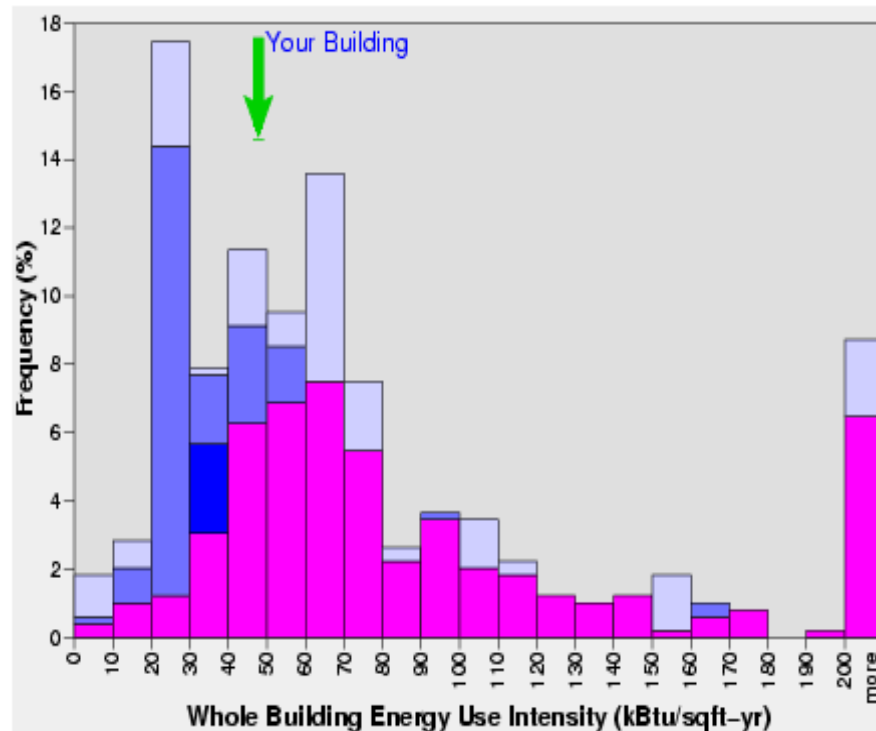
Document: Done

Simple on-line tool of
1990s CEUS data

Initial screen for Retro-
Cx Program, use by
PG&E

Only public source of
CEUS data

Whole Building Energy Use



Your whole building EUI is 47.7963 kBtu/ft²-yr, which is higher than 37 % of comparison buildings shown.

EUI Summary

%-tile	kBtu/ft ² -yr
25	34
50	58
75	90
Your EUI	47.7963

[more information](#)

LEGEND

Bar Color	Data Source	For further information:
Magenta	PGE_CEUS	PGE CEUS
Dark Blue	SCE95L	1995 SCE Low-Res CEUS
Light Blue	SCE92L	1992 SCE Low-Res CEUS
Very Light Blue	SCE92H	1992 SCE High-Res CEUS

Description of Comparison Buildings

For this field: You entered: Comparison Buildings

Building Type Office/Professional [Office/Professional](#)

Zip Code Not entered [All climate zones are shown](#)

Floor Area 50,000 ft²

Filter by area? No [Buildings of all sizes are shown](#)

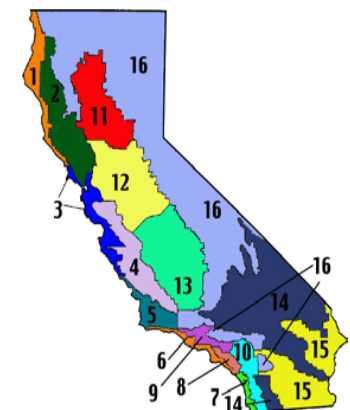
Site/Source Site [Results are displayed as site energy use](#)

Number of buildings on graphs:

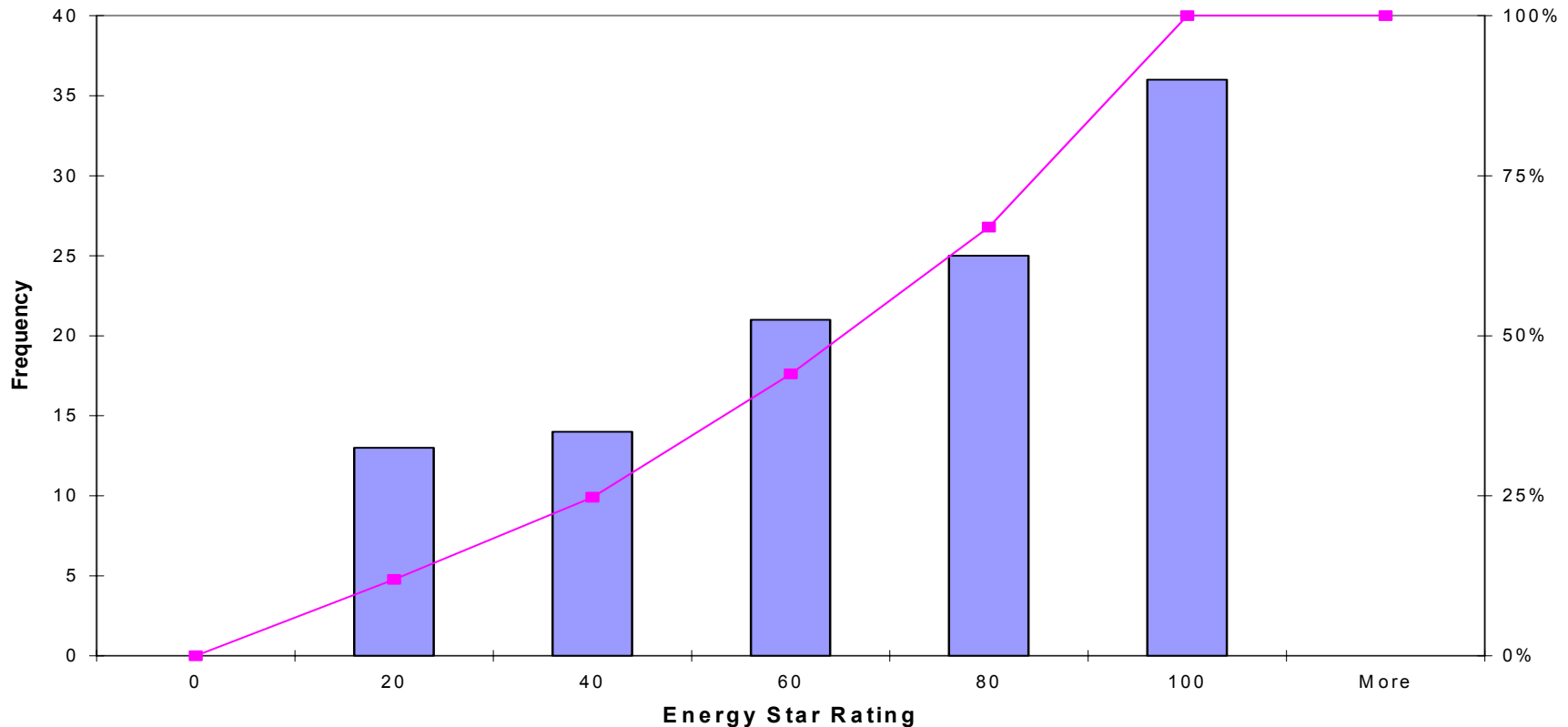
Whole Bldg	Electric	Gas
267	423	210

Continue to [Interpret Results](#) page for additional information about these results.

Was this helpful? Please take our [SURVEY](#)



California Buildings Achieve High Scores (n = 109 office buildings)



- **Analysis of 109 Offices from 1990s CEUS with New Energy Star Rating Algorithm (43 % >75)**
- **No Correlation between Energy Star score and % Better than Code**

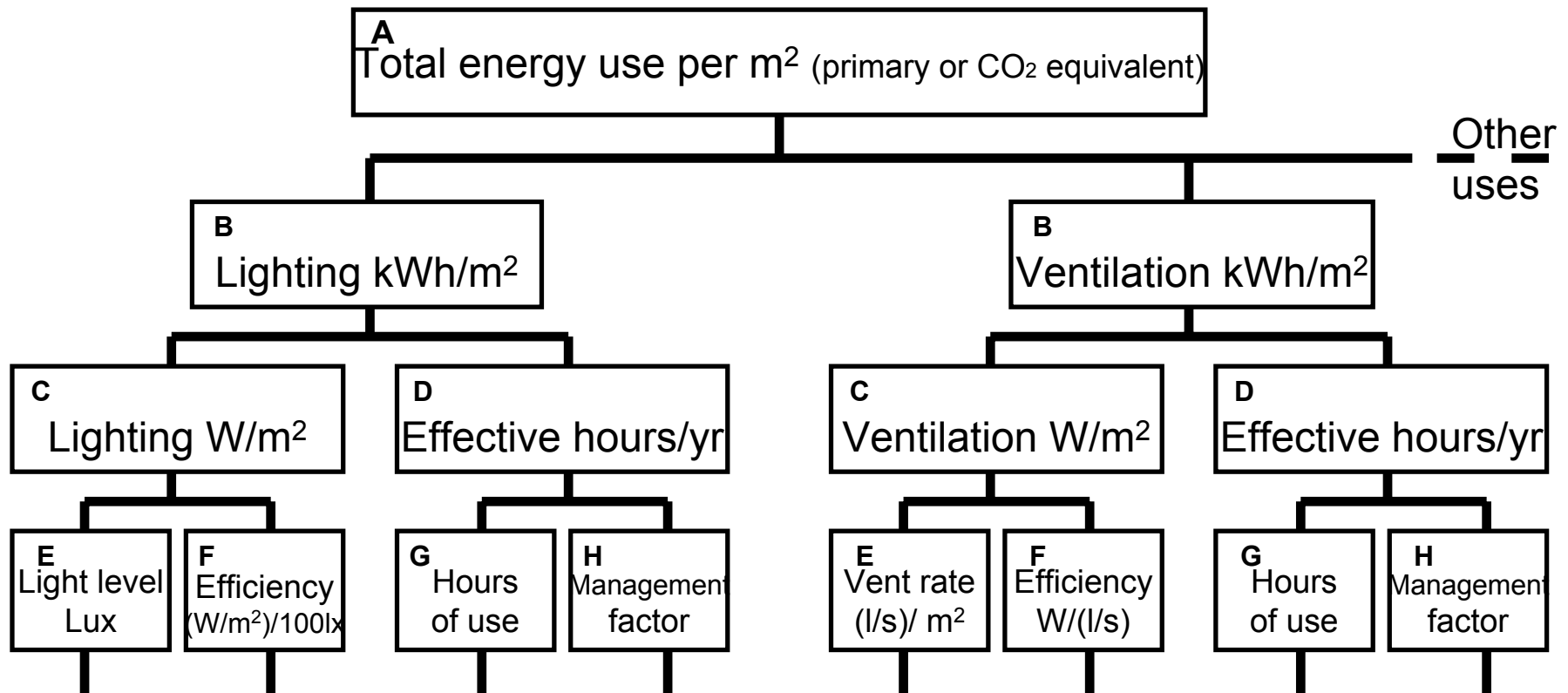


Features of Future Benchmarking Tools

- Review presence of efficiency features, consider controls, operations, and misc. equipment
- Link to code – Title 24 – as baseline for efficiency measures
- Move toward end-use evaluation
- Link to recommendations for strategies to reduce energy, both retrofits and retro-commissioning
- **UK Benchmarking Approach (for European Union)**
 - **Variables** - Identify variables that drive differences in EUIs
 - **Levels of Practice** - For each variable identify typical, good, excellent
 - **Models** – Develop models using variables to explain energy use
 - **Use Models to Adjust Benchmark** - compared building with benchmark
 - **Reducing Energy Use** - After developing benchmark methods on how buildings are used, add detail about opportunities for improvement

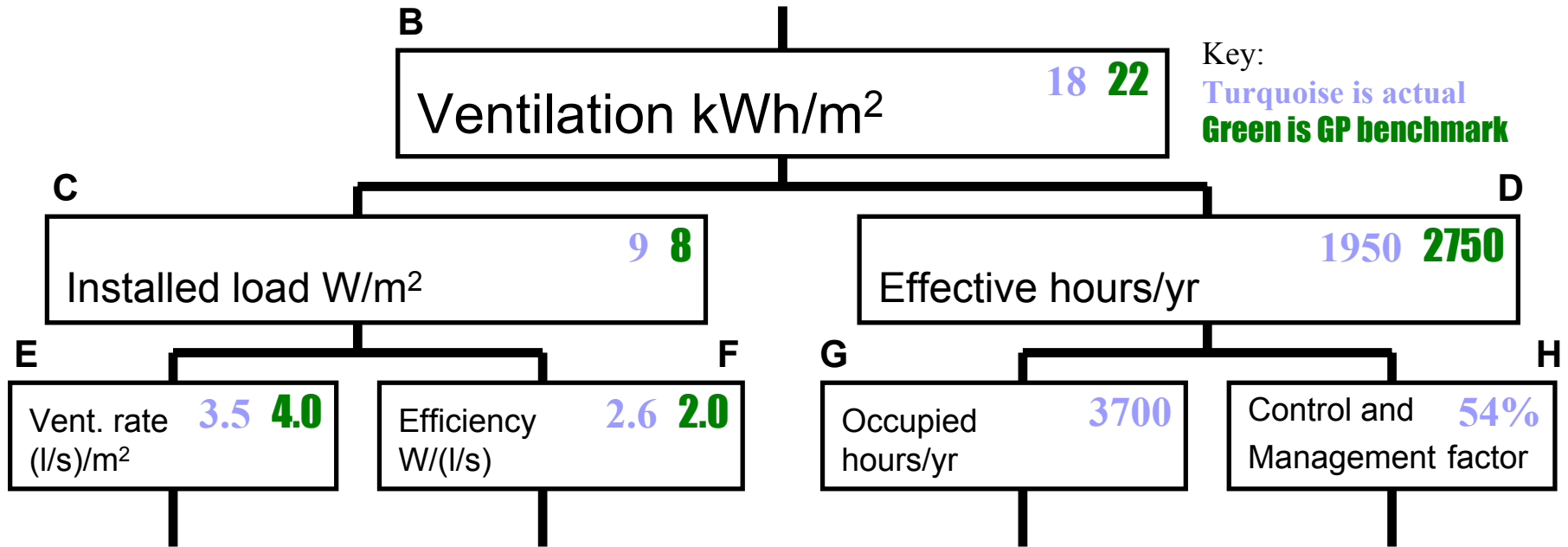
Analysis of Energy Use and Service Provision

Each box can be considered as a benchmark



Ventilation Energy in an Air-Conditioned Office

Each box can be considered as a benchmark

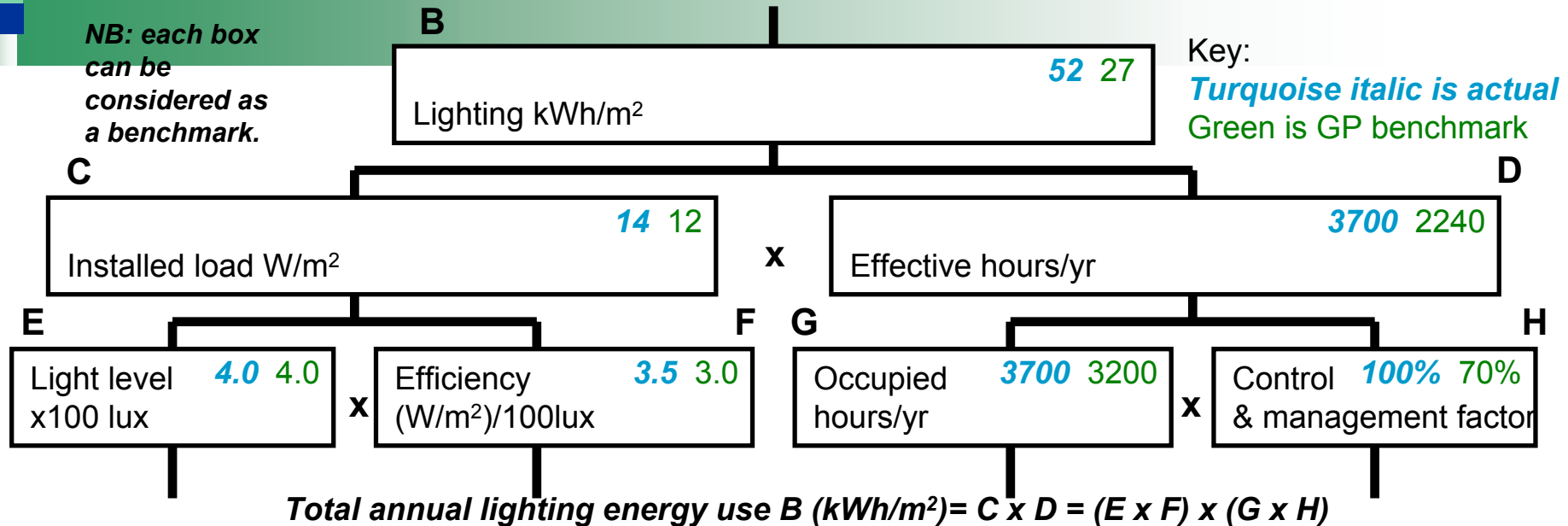


Air handling benchmarks:

	GOOD:		TYPICAL:	
	Type3	Type4	Type3	Type4
	Air cond	Prestige	Air cond	Prestige
	Standard	HQ	Standard	HQ
E (l/s)/m²	4	4	4	4
F W/(l/s)	2	2	3	3
C W/m²	8	8	12	12
D hrs/year	2750	3000	3500	3700
B kWh/m²	22	24	42	44

Lighting Energy in an Office

NB: each box can be considered as a benchmark.



Lighting benchmarks: typical (Source: ECON 19 [2])

	Type1	Type2	Type3	Type4
	Nat vent Prestige Cellular	Nat vent Open plan	Air cond Standard	HQ

C W/m²	15	18	20	20
G hrs/year	2500	3000	3200	3500
H % on	60%	70%	85%	85%
B kWh/m²	23	38	54	60

Benchmarks: good practice (GP), from ECON 19 [2]

	Type1	Type2	Type3	Type4
	Nat vent Prestige Cellular	Nat vent Open plan	Air cond Standard	HQ

C W/ m²	12	12	12	12
G hrs/year	2500	3000	3200	3500
H % on	45%	60%	70%	70%
B kWh/ m²	14	22	27	29



Next Steps

- **LBNL Develop Plan for Future Benchmarking Tool**
 - Investigate applicability of advanced methods to California
 - Review CEUS, evaluate use of Title 24 as benchmark in CEUS
 - Develop initial distributions of EUIs linked to standards of practice
- **DGS Opportunities**
 - Assemble building stock data
 - Size, location, systems, equipment, end-uses, occupancy, etc.
 - Energy use, peak demand
 - Controls, recent retrofits and retro-commissioning
 - Apply current and future benchmarking methods
 - Prioritize energy savings opportunities